



ESPACER 300

Technical Data Sheet

SHOWA DENKO

1. Introduction

Spacer 300 is a charge dissipating agent, the principal ingredient of which is a conducting polymer. A spun film of Spacer 300 shows high electron conductivity, and can solve a charging problem in electron beam lithography and other irradiating processes with charged particle beams.

We believe customers using Spacer 300 in electron beam lithography will be satisfied with its performance, owing to the following features:

- It has an excellent charge dissipating effect.
- It has no adverse effect on resolution of resists.
- It can be applied not only onto conventional resists but also onto chemically amplified resists.
- There are cases where it can protect the resist as an acidic polymer film.
- The spun film has sufficient heat resistance in practical uses.
- Water alone is used as solvent.
- It has neither a flash point, nor an ignition point, nor flammable limits.
- It can be easily removed with water after exposure.

In using Spacer 300, please carefully observe the instructions contained in this technical data sheet.

2. Identity Information / Specific Chemical Identity; Common Name(s)

Aqueous solution of poly[isothianaphthenediyl sulfonate] and surfactants.

3. Physical / Chemical Characteristics

Appearance : Dark blue liquid

Boiling Point : About 100 °C

Vapor Pressure : About 24 mmHg (25 °C)

Vapor Density : About 0.6 (Air = 1)

Evaporation Rate : Almost the same as that of water

Specific Gravity : 1.001~1.007 (25 °C)

Solubility : Freely miscible with water

pH : 3.0~6.0

Melting Point : About 0 °C

Odor : Low sulfur odor

4. Fire and Explosion Hazard Data / Reactivity Data

Flash Point : N.A.

Ignition Point : N.A.

Flammable Limits : N.A.

Stability : The value of pH slightly decreases during storage at 5 ± 3 °C.

Reactivity : Generates slight heat when neutralized by alkalis.

Corrosiveness : In our test, corrosion rate on SS-400 stainless steel was 0.9 mm/year.

Hazardous Decomposition : Combustion of the polymer may generate SO_x.

5. Packaging

Net 1 kg plastic bottle

6. Precautions for Safe Handling and Use

- (1) Espacer 300 is a weak acid solution containing a new chemical substance whose toxicity has not been fully examined. Be sure to avoid swallowing it and wear protective rubber gloves and goggles in handling.
- (2) Since Espacer 300 has low sulfur odor, workrooms should be ventilated, as occasion demands.

7. Emergency and First Aid Procedures

Eye contact : Immediately flush eyes with plenty of low-pressure water for at least 15 min.

Skin contact : Immediately wash affected area thoroughly with plenty of water and soap. Remove contaminated clothing immediately.

Inhalation of mist : Remove the affected person to fresh air immediately. If symptoms are observed, seek medical aid immediately.

Ingestion : In case of a small amount ingestion, watch a sign and symptom for some time. If symptoms are observed, seek medical aid immediately. In case of a large amount ingestion, immediately seek medical aid.

If symptoms are serious in any of the above cases, immediately seek medical aid.

If you need more detailed health hazard data on Espacer 300, we will provide Material Safety Data Sheet at your request.

8. In Case of Fire

Spacer 300 is nonflammable.

In case of fire in surrounding objects : Common fire-extinguishing agents can be used; for example, water, sand, fire-extinguishing powder, and so on. Special fire fighting procedures are not normally required.

9. Accidental Release Measures

In case of release of a small amount, wipe out with rags and incinerate the used rags.

In case of release of a large amount, dam up the stream with earth and sand, guide in the path of safety, and collect it as much as possible. Then flush with a large amount of water. Be sure to prevent thick waste from flowing out to the river.

10. Waste Disposal Method

Drainage : Neutralize with weak alkaline agent such as sodium hydrogen carbonate, decolor with bleaching powder, and treat to lower the COD value. Fully observe the applicable laws and regulations.

Combustion : Incinerate by the wet combustion method after neutralization.

Disposal of empty bottles : Incinerate empty bottles.

11. Recommended Materials for Apparatus in Contact with Espacer 300

(1) Since Espacer 300 is a weak acid solution, it slightly corrodes SS-400 stainless steel as described above. Thus metal is not suitable for material of an apparatus which comes in contact with Espacer 300 solution, such as a pipe for application system, a cup of spinner, a pipe for waste line, etc.

(2) The use of plastic materials or plastic coating is recommended as an acid-proof treatment. Polyethylene and polypropylene are suitable, but fluorinated plastic is the best. Polyacetal is not suitable, because it lacks acid resistance.

(3) A spun film of Espacer 300 can become corrosive by adsorbing moisture from the atmosphere. Corrosiveness of the film is expected to be weaker than that of the Espacer 300 solution. However corrodible metals such as aluminum are not recommendable as material of an apparatus in contact with the film, for example, a holder of a spun film, a grounded probe, etc. In case light metal is required, the use of titanium is recommended.

12. Storage

- (1) Store the product at 5 ± 3 °C in a refrigerator.
- (2) Avoid direct sunlight.

Please refer to the technical data on the following page regarding the shelf life of Espacer 300.

13. Shelf Life of Espacer 300

< Surface Resistance and pH Variation as a Function of Storage Time >

[Storage Temperature]

In Refrigerator ; $5 \pm 3 \text{ }^\circ\text{C}$ Room Temperature ; $24 \pm 2 \text{ }^\circ\text{C}$

[Application Conditions]

Substrate ; Glass substrate (60mm × 60mm × 1mm) Spin Speed ; 1500 rpm

Spin Time ; 70 sec Applied Volume of Espacer 300 ; 3 ml

Spinner ; Model 1H-III (Kyoei Semiconductor Co., Ltd.)

Espacer 300 taken out from the refrigerator was left at the room temperature for one hour before application.

[Measurement]

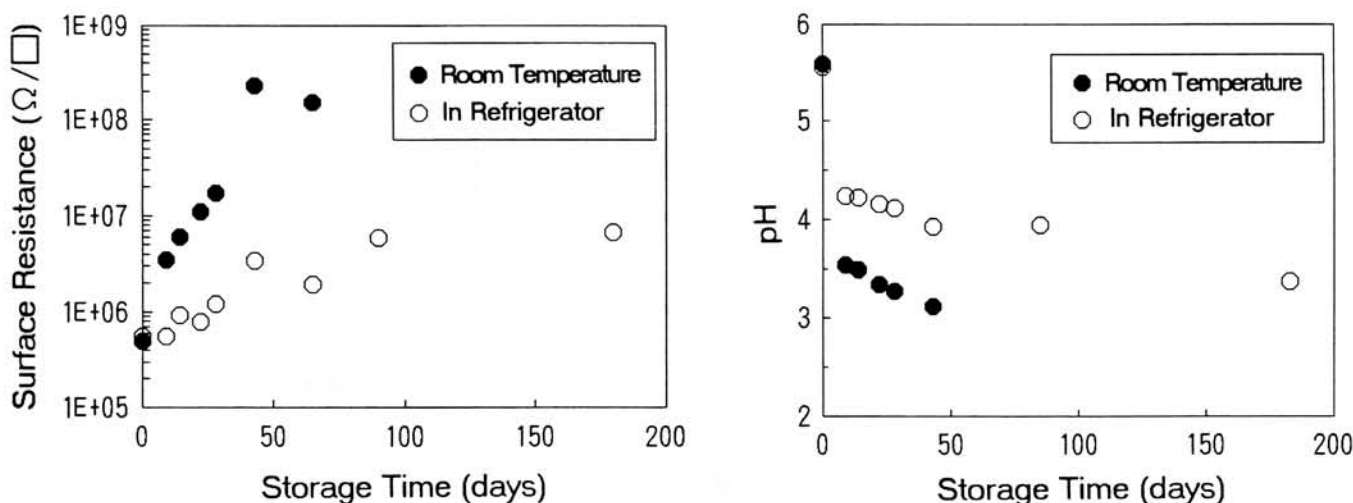
Surface Resistance Meter ; Megaresta Model HT-301 (Shishido Electrostatic, Ltd.)

Applied Voltage ; 10 V Applied Time ; 10 sec Probe ; HR type probe

pH Meter ; HORIBA pH-Meter F-13 (Horiba, Ltd.) (Electrode : 6366-10D)

Calibrated by phosphoric acid (pH=6.86; 25.0 °C), phthalic acid (pH=4.01; 25.0 °C) and oxalic acid (pH=1.68; 25.0 °C) buffer solutions.

[Result]



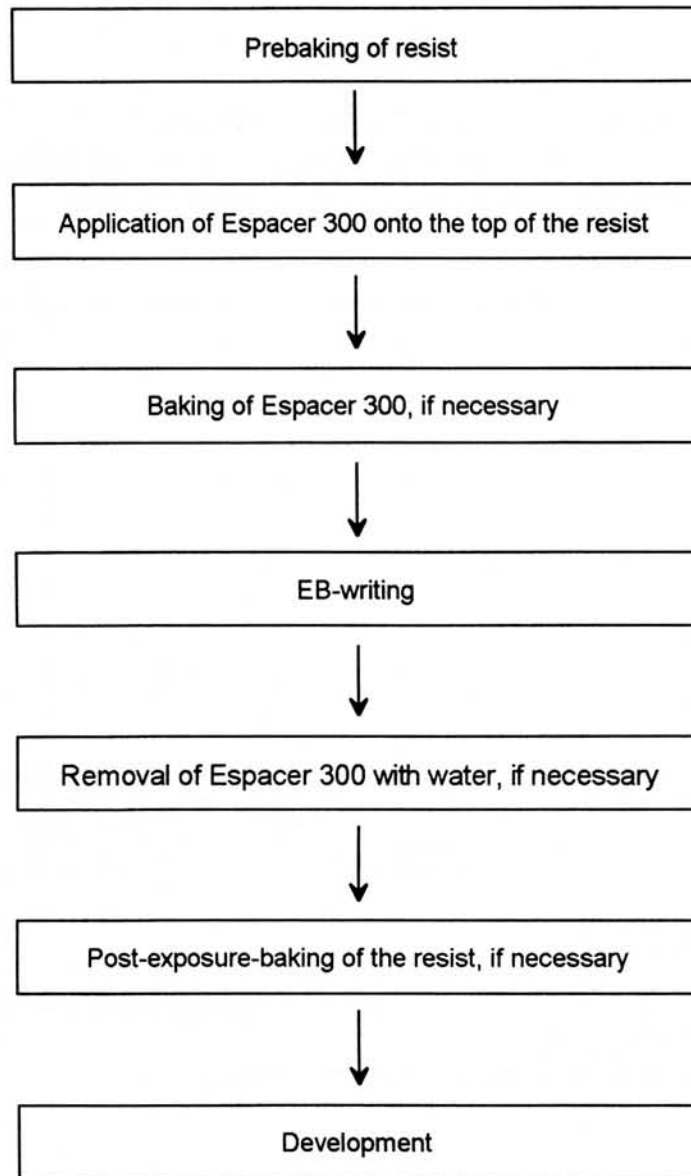
[Recommendation]

Espacer 300 should be stored in a refrigerator at $5 \pm 3 \text{ }^\circ\text{C}$.

Even after storage for 6 months at $5 \pm 3 \text{ }^\circ\text{C}$, the spun film showed surface resistance of $5 \times 10^7 \text{ } \Omega/\square$ or lower. In the case of storage at $24 \pm 2 \text{ }^\circ\text{C}$, it was found that the storage time should be approximately one month or shorter to ensure surface resistance of $5 \times 10^7 \text{ } \Omega/\square$ or lower.

As the spin condition depends on the solution temperature, Espacer 300 stored in the refrigerator should be spun after it is left at the room temperature for more than an hour.

14. Typical Process Flow (In Electron Beam Lithography)



14-1. Spin Conditions (1)

< Spin Speed Dependence of Film Thickness >

[Application Conditions]

Substrate ; <100> surface of N type 4" silicon wafer

Spin Time ; 90 sec Applied Volume of Espacer 300 ; 6.5 ml

Spinner ; Model 1H-360E-DLS (Kyoei Semiconductor Co., Ltd.)

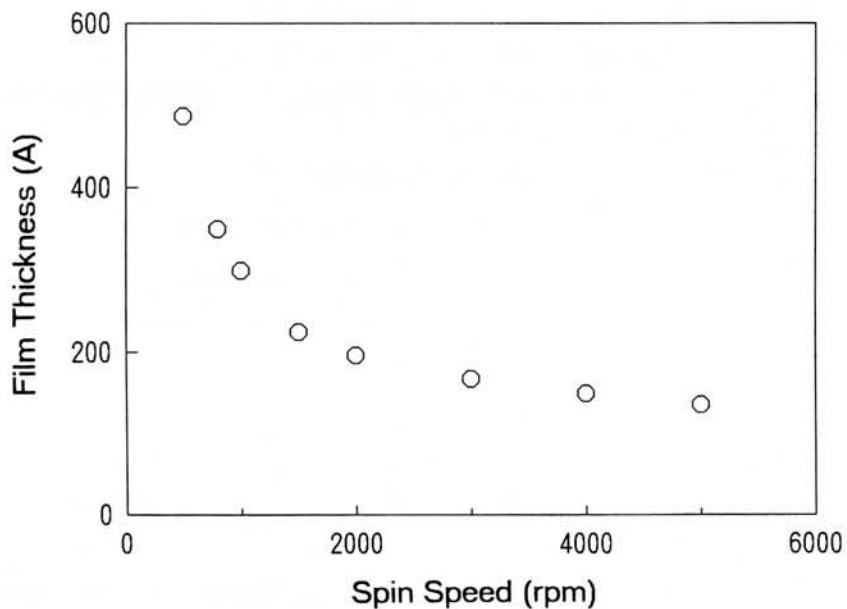
[Measurement]

The film thickness was measured by ellipsometry for 17 points on the surface, and the average was taken.

The value of thickness was calculated with the refractive index; $n=1.25$.

Ellipsometer ; Automatic Ellipsometer L115B (Gaertner Scientific Corporation)

[Result]



[Recommendation]

The spun film becomes thicker, as spin speed is made lower. When the spin speed is lower than 1000 rpm, the film surface could be uneven. Recommended spin speed is between 1500 rpm and 2000 rpm.

Spin conditions depend on the type of resist and the shape of substrate, etc., and should be determined by respective customers.

14-2. Spin Conditions (2)

< Spin Speed Dependence of Surface Resistance >

[Application Conditions]

Substrate ; Glass substrate (60mm×60mm×1mm) Spin Time ; 90 sec
Applied Volume of Espacer 300 ; 3 ml Spinner ; Model 1H-360E-DLS (Kyoei Semiconductor Co., Ltd.)
Temperature ; 25.0~25.5 °C Humidity ; 40.2~48.5 %

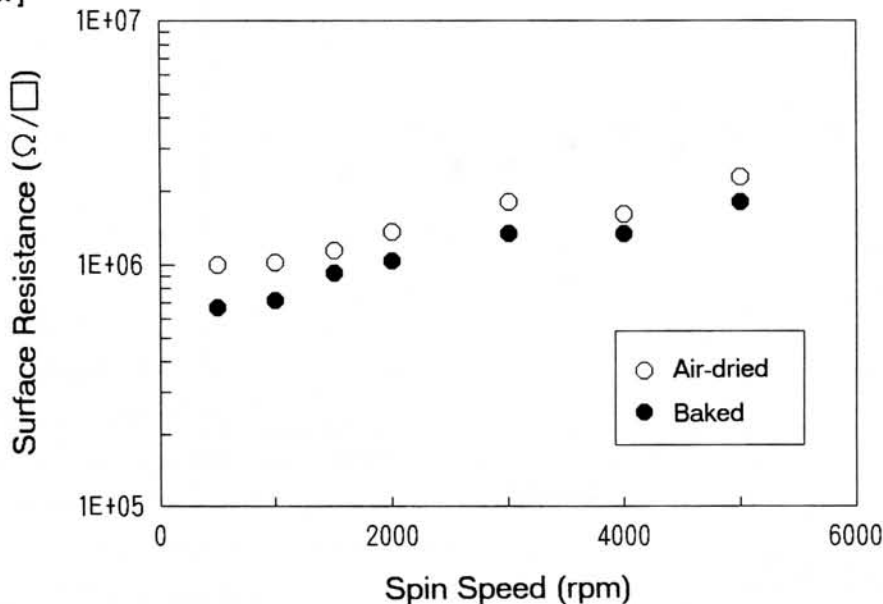
[Baking Conditions]

Oven ; Drying Oven DV41 (Yamato Scientific Co., Ltd.)
Baking Temperature ; 100 °C Baking Time ; 10 min
The film was air-dried for 30 min after application and then baked.

[Measurement]

Surface Resistance Meter ; Megaresta Model HT-301 (Shishido Electrostatic, Ltd.)
Applied Voltage ; 10 V Applied Time ; 10 sec Probe ; HR type probe
Temperature ; 25.0~25.5 °C Humidity ; 40.2~48.5 %
The surface resistance was measured 30 min after application for air-dried samples. As for baked samples, the surface resistance was measured 5 min after completion of baking.

[Result]



[Recommendation]

The surface resistance is almost the same in the range of spin speed between 500 rpm and 5000 rpm. For baked samples, the surface resistance is slightly lower than that of air-dried samples, but the spin speed dependence is almost the same as that of air-dried samples.

The surface resistance becomes slightly lower, as the spin speed is made lower. When the spin speed is lower than 1000 rpm, the film surface could be uneven. The recommended spin speed is between 1500 rpm and 2000 rpm. Spin conditions depend on the type of resist and the shape of substrate, etc., and should be determined by respective customers.

14-3. Baking Conditions

< Baking Temperature Dependence of Surface Resistance >

[Application Conditions]

Substrate ; TEMPAX hard glass substrate (60mm×60mm×1mm) Spin Speed ; 1500 rpm

Spin Time ; 90 sec Applied Volume of Espacer 300 ; 3 ml

Spinner ; Model 1H-360E-DLS (Kyoei Semiconductor Co., Ltd.)

Temperature ; 24.0~25.4 °C Humidity ; 43.1~46.5 %

[Baking Conditions]

Oven ; Drying Oven DV41 (Yamato Scientific Co., Ltd.)

Baking Temperature ; 60~200 °C Baking Time ; 10 min

The film was air-dried for 30 min after application and then baked.

[Measurement]

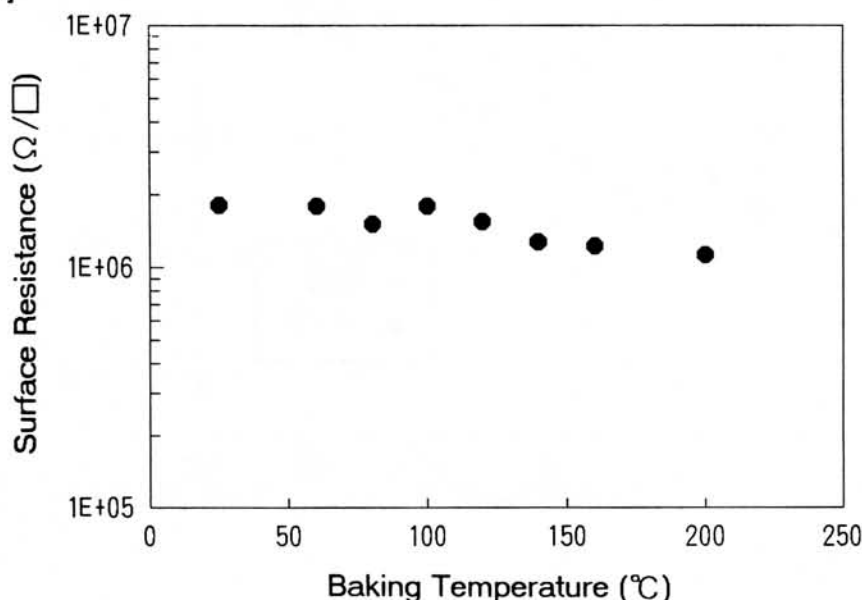
Surface Resistance Meter ; Megaresta Model HT-301 (Shishido Electrostatic, Ltd.)

Applied Voltage ; 10 V Applied Time ; 10 sec Probe ; HR type probe

Temperature ; 24.0~25.4 °C Humidity ; 43.1~46.5 %

The surface resistance was measured 5 min after completion of baking at various temperatures.

[Result]



[Recommendation]

The surface resistance is almost the same in the range of the baking temperature between 60 °C and 200 °C. The surface resistance becomes slightly lower, as the baking temperature is made higher. The higher baking temperature could adversely affect the performance of certain types of resist.

Baking conditions depend on the type of resist, etc., and should be determined by respective customers.

14-4. Film Life of Espacer 300

< Surface Resistance as a Function of Time after Application >

[Application Conditions]

Substrate ; Glass substrate (60mm×60mm×1mm) Spin Speed ; 1500 rpm Spin Time ; 90 sec
Applied Volume of Espacer 300 ; 3 ml Spinner ; Model 1H-360E-DLS (Kyoei Semiconductor Co., Ltd.)
Temperature ; 23.7~24.7 °C Humidity ; 44.8~45.3 %

[Baking Conditions]

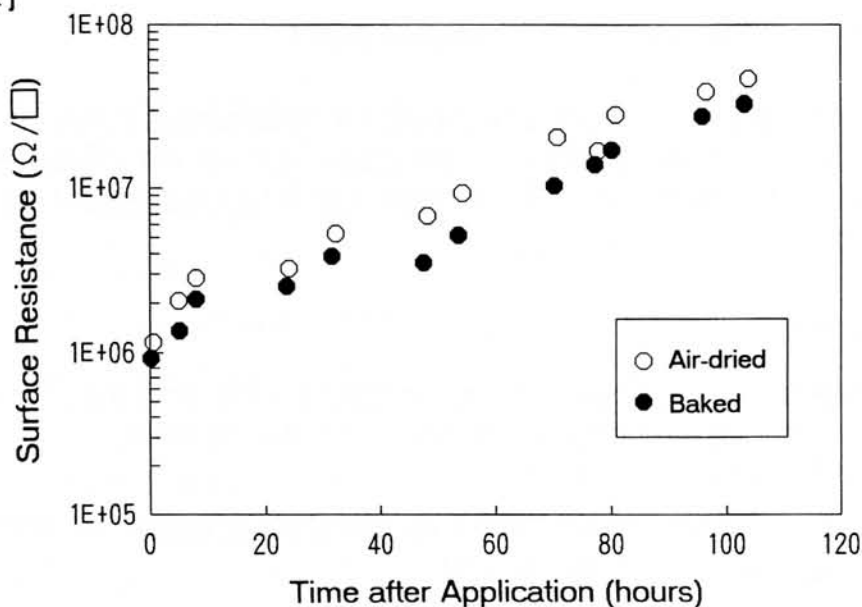
Oven ; Drying Oven DV41 (Yamato Scientific Co., Ltd.)
Baking Temperature ; 100 °C Baking Time ; 10 min
The film was air-dried for 30 min after application and then baked.

[Measurement]

Surface Resistance Meter ; Megaresta Model HT-301 (Shishido Electrostatic, Ltd.)
Applied Voltage ; 10 V Applied Time ; 10 sec Probe ; HR type probe
Temperature ; 23.5~25.5 °C Humidity ; 42.5~48.5 %

As for air-dried samples, the surface resistance was measured as a function of time immediately after application. In case of baked samples, measurement was made as a function of time immediately after baking.

[Result]



[Recommendation]

Although baked samples showed slightly lower surface resistance, air-dried samples continued to show surface resistance of $5 \times 10^7 \Omega/\square$ or lower for more than 100 hours.

The surface resistance of a spun film can be influenced by humidity. We recommend that measurement should be made in a room with controlled humidity and temperature.

Detailed conditions should be determined by respective customers in view of specific conditions of use.

14-5. Removal

< Baking Temperature Dependence of Removal Characteristics of Spun Film >

[Outline of Measurement]

To determine whether or not Espacer 300 remains on substrate after water-rinse, an elemental analysis of sulfur atom was made with ESCA (Electron Spectroscopy for Chemical Analysis).

[Application Conditions]

Substrate : TEMPAX hard glass substrate (60mm×60mm×1mm) Spin Speed : 1500 rpm

Spin Time : 90 sec Applied Volume of Espacer 300 : 3 ml

Spinner : Model 1H-360E-DLS (Kyoei Semiconductor Co., Ltd.)

Temperature : 24.0~25.4 °C Humidity : 43.1~46.5 %

[Baking Conditions]

Oven : Drying Oven DV41 (Yamato Scientific Co., Ltd.)

Baking Temperature : 60 °C, 80 °C, 100 °C, 120 °C, 140 °C, 160 °C, 200 °C

Baking Time : 10 min

The film was air-dried for 30 min after application and then baked.

[Removal Condition]

The film was rinsed for 30 sec with 20 ml of running water.

[Measurement]

ESCA apparatus : SSX-100 (Surface Science Instruments)

[Result]

No sulfur atom was detected on the rinsed substrate after baking at any of the above-mentioned temperatures. The same result was obtained for a non-baked substrate. It was confirmed that the spun film of Espacer 300 could be removed by water-rinse as long as baking is conducted at temperatures up to 200 °C.

[Recommendation]

The spun film of Espacer 300 can be removed after baking at between 60 °C and 200 °C. However, baking at high temperatures could adversely affect removal characteristics.

Detailed baking conditions depend on the type of resist, etc., and should be determined by respective customers.

When you remove Espacer 300 from resist, we recommend low-speed spinning rinse with running water for 1 min.

SHOWA DENKO K.K.

For further information, please
contact one of the following:

Commercial Subsidiaries (Domestic)

Planning Department, Electronics Sector, Showa Denko K.K.

13-9, Shiba Daimon 1-Chome, Minato-ku, Tokyo 105-8518 Japan

TEL : +81-3-5470-3277

FAX : +81-3-5473-0590

URL <http://www.sdk.co.jp>

Commercial Subsidiaries (Overseas)

Showa Denko America, Inc.

NY Head Office

489 Fifth Avenue, 18th Fl. New York, N.Y. 10017 U.S.A.

TEL : +1-212-370-0033

URL <http://www.showadenkoamerica.com>

San Francisco Office

2880 Lakeside Drive, Suite 253, Santa Clara, CA 95054 U.S.A.

TEL : +1-408-327-8878

Showa Denko Europe GmbH

Martin-Kollar Strasse 10, 81829 Munich

TEL : + 49-89-9399620

Showa Denko Singapore(Pte.)Ltd.

4 Shenton Way #16-01 SGX Centre 2, Singapore 068807

TEL : +65-6223-1889

URL <http://www.sds.com.sg>